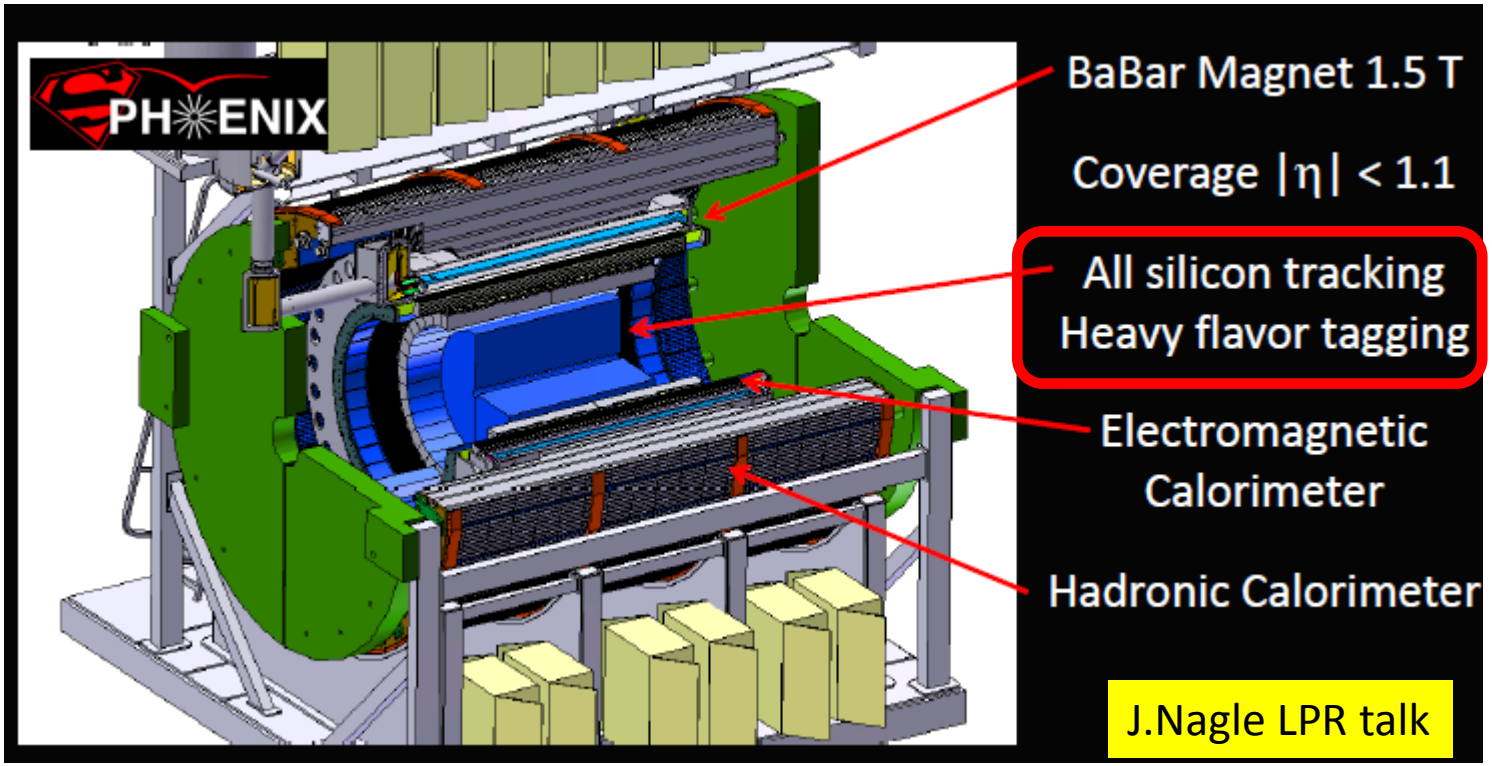
sPHENIX Silicon Tracker Japanese Funding possibility

Y. Akiba (RIKEN/RBRC)

2015/11/09

sPHENIX Cost and Schedule review

sPHENIX reference design



- Central Tracker for
  - Precision measurement of jet structure
  - b-tagged jet
  - 3 Upsilon states (100MeV resolution required)
- We are seeking for Japanese funding for the sPHENIX tracker

Effort for KAKENHI funding for the tracker

- I submitted a large KAKENHI grant proposal to JSPS.
  - JSPS is the main funding agency in Japan. Its function is similar to NSF in the US
- The grant asked for total of 4.9 oku yen (~$5M) over 5 years from JFY2016 to JFY2020.
  - JFY2020 ends March 2021. So this matches sPHENIX schedule
  - In the JSPS grant system, we receive the full amount of the allocated fund. Overhead will be provided separately.
  - The grant ask for 4.52 oku-yen for Si Tracker (4.22 oku-yen material cost). The Si-tracker in the JSPS proposal is exactly the same one as in the pCDR.
- Last year, I submitted a similar one. I went to an interview (20 of 74 application went to interview), but failed at the interview (10 of 20 accepted).

Proposed Si Tracker (JSPS and pCDR)

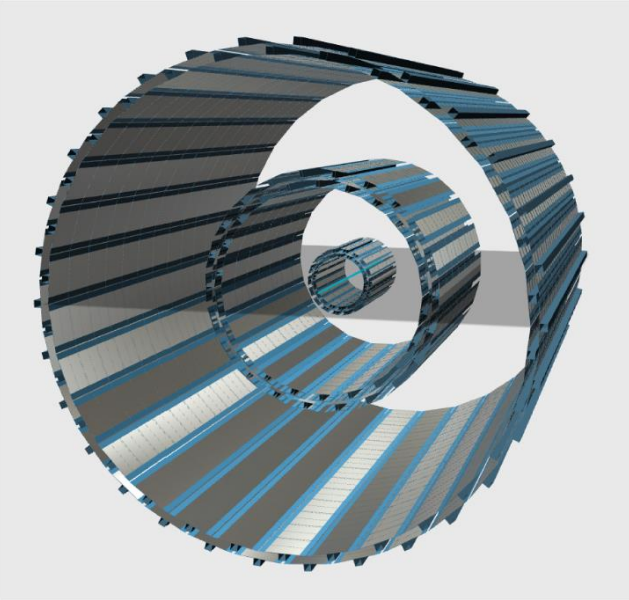


Figure 4.1: CAD drawing of the silicon strip tracker

Station	Layer	radius (cm)	pitch (μm)	sensor length (cm)	depth (μm)	total thickness X_0%	area (m^2)
Pixel	1	2.4	50	0.425	200	1.3	0.034
Pixel	2	4.4	50	0.425	200	1.3	0.059
S0a	3	7.5	58	9.6	240	1.0	0.18
S0b	4	8.5	58	9.6	240	1.0	0.18
S1a	5	31.0	58	9.6	240	0.6	1.4
S1b	6	34.0	58	9.6	240	0.6	1.4
S2	7	64.0	60	9.6	320	1.0	6.5

Table 4.2: Number of channel summary for the silicon strip tracker.

station	sub-layer	silicon modules per ladder	# of ladders	# of sensors
S0	2	3	36	216
S1	2	7	44	617
S2	1	14	48	672

- The silicon tracker in the pCDR is the same one that I requested for the JSPS grant
- Size of tracker (R~64cm at S2) is minimum to achieve required Upsilon mass resolution (100 MeV) to fit in the 5-oku yen upper limit of the JSPS grant

JSPS grant proposal

Front page of ~40 page proposal document

Name of the PI (AKIBA, Y)

Requested Budget Profile

4.9 oku-yen for 5 years

平成28年度　特別推進研究　研究計画調書（新規）
PROPOSAL FOR GRANT-IN-AID FOR SPECIALLY PROMOTED RESEARCH（FY2016）

平成 27 年10月28日

研究代表者氏名 Principal Investigator (PI)	(フリガナ)	アキバ　ヤスユキ
	(漢字等)	秋葉　康之
	(in Roman Letters)	Akiba, Yasuyuki
所属研究機関 Institution (University, College, etc.)	(番号) 82401	理化学研究所 RIKEN(The Institute of Physical and Chemical Research)
部局 Academic Unit (School, Faculty, etc.)	(番号) 999	仁科加速器研究センター RIKEN Nishina Center
職 Position	(番号) 25	副主任研究員 Vice Chief Scientist
研究課題名 Title of Proposed Project	RHICの新ジェット測定実験とビームエネルギー走査による超高温クォーク物質の解明 Elucidation of quark gluon plasma with jet probes and the beam energy scan II at RHIC	

研究経費 Budget for Proposed Project（千円未満の端数は切り捨てる）　Converted to U.S.$ at 1 Dollar = 120 Yen

年度 FY	研究経費（千円） Annual Budget [U.S.$]	使用内訳（千円） Details 設備備品費 Equipment	消耗品費 Consumables	旅費 Travel Expenses	人件費・謝金 Personnel (Technical Assistant, Labor Cost, etc.)	その他 Miscellaneous
平成28年度 2016	60,400 [503,333]	500 [4,167]	20,000 [166,667]	1,400 [11,667]	6,000 [50,000]	32,500 [270,833]
平成29年度 2017	118,050 [983,750]	500 [4,167]	83,750 [697,917]	1,800 [15,000]	12,000 [100,000]	20,000 [166,667]
平成30年度 2018	122,350 [1,019,583]	500 [4,167]	84,500 [704,167]	2,250 [18,750]	12,000 [100,000]	23,100 [192,500]
平成31年度 2019	112,800 [940,000]	0 [0]	78,950 [657,917]	2,250 [18,750]	12,000 [100,000]	19,600 [163,333]
平成32年度 2020	77,150 [642,917]	18,000 [150,000]	29,300 [244,167]	2,350 [19,583]	12,000 [100,000]	15,500 [129,167]
総計 Total Amount	490,750 [4,089,583]	19,500 [162,500]	296,500 [2,470,833]	10,050 [83,750]	54,000 [450,000]	110,700 [922,500]

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審査希望分野（系等の区分）	理工系（数物系科学）				
（1）最も関連の深い研究 分野（細目）	細目番号	4901	（2）次に関連の深い研究 分野（細目）（任意）	細目番号	
	分野	数物系科学		分野	
	分科	物理学		分科	
	細目	素粒子・原子核・宇宙線・宇宙物理		細目	
研究計画最終年度前年度の応募	応募しない （平成28年度が研究期間の最終年度に当たる研究計画の課題番号を記入）				
海外の研究者による審査の適否	適当である				
機関・整理番号	82401-0002				

"Project description" from the English part of the proposal

PROJECT DESCRIPTION (Continued)

The first of these goals will be achieved by sPHENIX[1], a new detector at RHIC. A drawing of the sPHENIX detector is shown in Fig. 1. The sPHENIX detector is a large acceptance, high rate detector consisting of a superconducting solenoid with inner radius of 140 cm, a charged particle tracker, electromagnetic calorimetry, and hadronic calorimetry providing uniform coverage for $|\eta|<1.0$. The detector can record 50 billion minimum bias Au+Au collision events in 20 weeks. The detector can measure more than 10^7 unbiased jets, 10^5 bottom jets and 10^4 direct photons for $p_T > 20$ GeV/c. The high statistics jet samples will be used to probe QGP at very short distances, and the quark mass dependence of jet energy loss will be studied with the b-jet samples. The detector also can make high statistics measurements of the three Upsilon states. These measurements are complementary to jets and quarkonia measurements at the LHC.

The sPHENIX proposal underwent a DOE Science Review in July 2014 and the follow-up review in April 2015. The review panel found, "The science questions that measurements with sPHENIX will answer are of great significance not only to QCD and heavy-ion physics, but to the larger nuclear and particle physics community". The physics case has strong support in the US nuclear physics community. The NSAC long range plan wrote that "a state-of-the art jet detector at RHIC, called sPHENIX" is essential to complete the QGP study at RHIC.

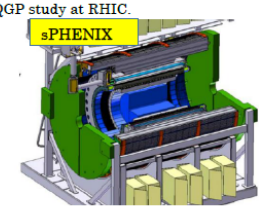


Figure 1 sPHENIX detector (from sPHENIX proposal[1])

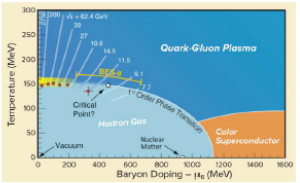


Figure 2 Phase diagram of QCD matter (from NSAC LRPR 2015[2])

The second goal will be achieved by RHIC Beam Energy Scan-II (BES-II). Figure 2 show the phase diagram of QCD matter. It is theoretically expected that there is a critical point where the nature of the transition between the QGP and hadronic gas changes from a rapid cross-over at low baryon density to the 1st order phase transition at high baryon density. In BES-II, high statistics data of Au+Au collisions at beam energy $7 < \mathrm{sqrt(sNN)} < 20$ GeV will be measured to search for this critical point. The critical point is the most important landmark of the QCD phase diagram.

(3)Research Objectives and Targeted Goals of this Project

The first objective of this project is precise measurement of jets with sPHENIX. For this purpose, Akiba will construct the silicon tracker of sPHENIX. The trakcer is essential for the physics capability of sPHENIX, but it is not currently funded from the US side due to limited budget. The silicon tracker will provide the following physics: (A) precise measurements of the modification of jet structure and energy flow around the jets to elucidate how quarks and gluons interact with the QGP medium; (B) measurement of b-tagged jets to study the quark mass dependence of energy loss; (C) measurement of the suppression of the three Upsilon states, which is essential to understand the confinement mechanism of QCD. The high mass resolution of the silicon tracker is essential for this measurement.

The second objective of the project is to search for the QCD critical point in BES-II. Esumi will join STAR collaboration during BES-II and analyzes the data from STAR detector.

In the running plan for RHIC, the BES-II run is scheduled in 2019 and 2020, and the completed sPHENIX detector will start taking data in US FY2021. The five year period of this project (April 2016 to March 2021) matches very well with this schedule.

References

[1] "An upgrade Proposal from the PHENIX Collaboration" arXiv:1501.06197 (2015).
[2] "The 2015 Long Range Plan for Nuclear Science", http://science.energy.gov/~/media/np/nsac/pdf/2015LRP/2015_LRPNS_091815.pdf

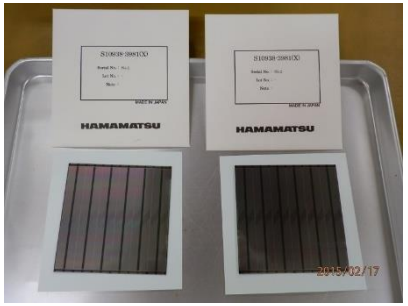
Requested funding profile to JSPS

Unit: 100K yen ~ $1K

	JFY2016	JFY2017	JFY2018	JFY2019	JFY2020	Total
Prototype	300	0	0	0	0	300
FPHX	200	0	0	0	0	200
Sensor production	0	660	660	401	0	1721
Ladder assembly	0	335	366	245	128	1074
ROC/FEM	0	0	0	300	450	750
Misc	20	40	40	40	40	180
Total	520	1035	1066	986	618	4225

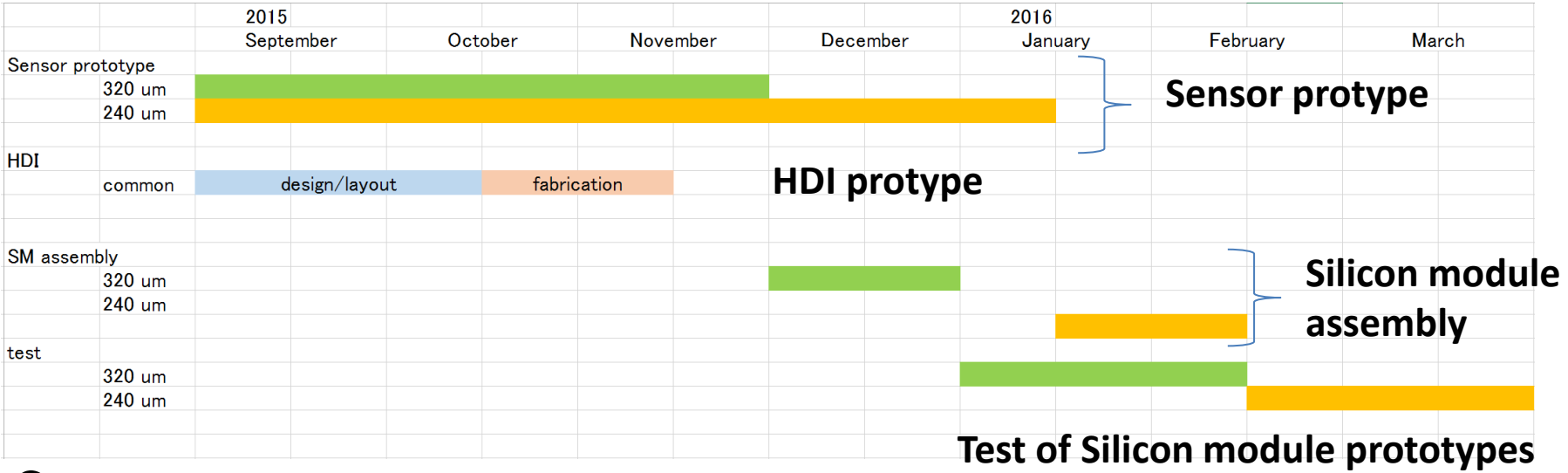
- The budget profile of the M&S of Si-Tracker in the grant proposal
- The Grant cover prototype and M&S of the tracker hardware
  - JFY2016 Prototyping of ladders (S0,S1,S2)
  - JFY2017-2019 production of sensor and ladders
  - JFY2019,20 ROC/FEM
- Complete the tracker by the first half of JFY2020 (Sep 2020)
- NOTE: RIKEN/RBRC personnel will work on the project, but not in the JSPS funding request above.

R and D effort at RIKEN



JFY2014: ~$70K for S2 sensor prototype
5 pcs of sensor delivered March 2015
- Vfd=50V; Vbreak>250V; No NG channel

JFY2015: ~$300K for S1 silicon module prototype



Status:

Sensor: HPK is making the sensor. On track for the schedule.

HDI: design completed. Fabrication will start soon.

Summary

- JSPS grant proposal for sPHENIX silicon tracker was submitted
  - About 4.2 oku-yen of hardware money for 5 years from April 2016 to March 2021
- If accepted, most of the M&S cost of the silicon tracker hardware (sensor, ladder assembly, ROC/FEM) can be covered by the grant
- We understand we must expand the manpower working in this project to successfully carry out.
- We are actively pursuing new collaborators to work on the Si tracker project and look forward to the first sPHENIX collaboration meeting at Rutgers in December.